

On Anomalous Proton losses at the beginning of the store, Vertical Tunes Off ?

While analyzing the luminosity lifetime analysis, we discovered that the proton lifetime is often much shorter than the anticipated lifetime based on the collision rate. This has been pointed by many of us (Alvin T., Jerry A., V. L..) We also compared the emittance growth rates from SyncLite data to IBS, and established semi-quantitative success if these anomalous (i.e., of unknown origin) are small (i.e., smaller than the losses due to collision rate, typically placing the cut at 0.5 MHz per bunch, corresponding to a lifetime of 100 hours). For instance we show on figure 1 and 2 two correlation plot between the predicted growth rate based on IBS theory versus the growth rate measured by the Sync Light.

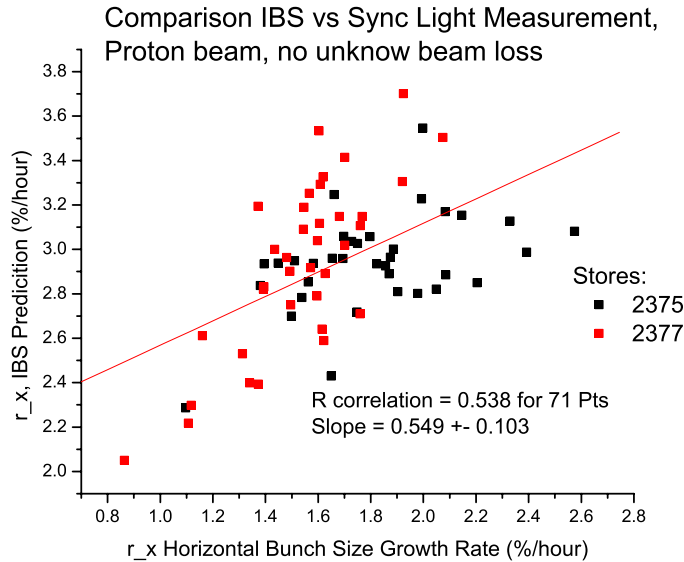


Figure 1 : Correlation between predicted and measured IBS growth rate, When losses are small.

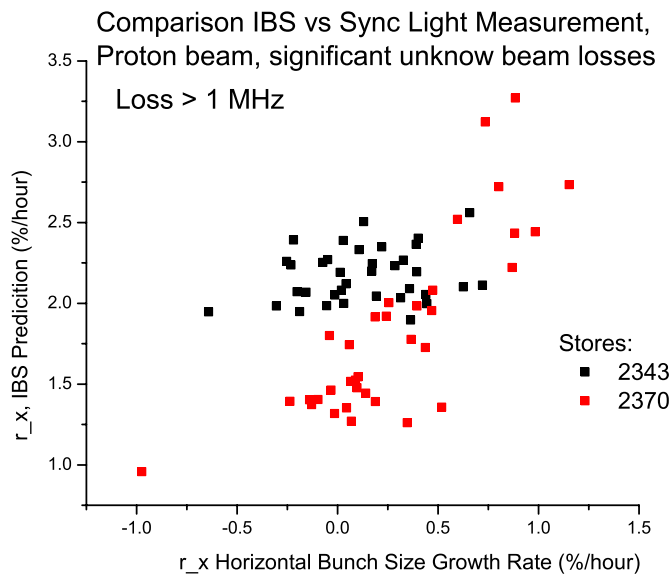


Figure 2 ; Same quantities as previous figures, we now have large anomalous losses.

Note the significant shift in the horizontal scale: despite a significant IBS growth rate, the bunch no longer expand in the Horizontal plane. It is quite reasonable to assume that scraping occurs. A similar reduction of the longitudinal growth rate has been seen.

Why are we scraping, in all 3 planes? Previous search for hints gave no results: the anomalous loss rates are not correlated with transverse emittance (reported by Flying Wire) and are not correlated with the bunch length. This can be seen for these 4 stores recently studied (2343, 2370, 2375, 2377) (figure 3). For these first two stores, the anomalous loss are high, and are low for the last two stores. Presumably, the dynamical aperture of the Tevatron changes over time, but how can we prove this.

A hint of an explanation could come from the Tune fitter, and/or (possibly, to be confirmed!) from the Shottky power in the vertical plane. The last 4 figures show the tunes reported by the Tune Fitter looking at the Horizontal pick-up for the first two hours of the stores. For the “good stores” (2375, 2377), the vertical line is just too hard to dig-out from the noise. This is indicated by the large error bars on the tune measurement: the search for the narrow synchro-betatron tune splits fails, the result comes from the fit of the broad bump. If so, the coherent vertical betatron excitations are pretty low. Note also that the broad peak is at a relatively lower tune (~ 0.574)

The bad store have definitely to “strong tunes”, the Synchro-lines are now visible on the vertical plane. Also, the vertical tunes are higher. Evidently, if the tunes are set differently, it could explain why the dynamical aperture changes. Results based only on 4 stores are probably a bit misleading, further data analysis is probably warranted to reach conclusion..

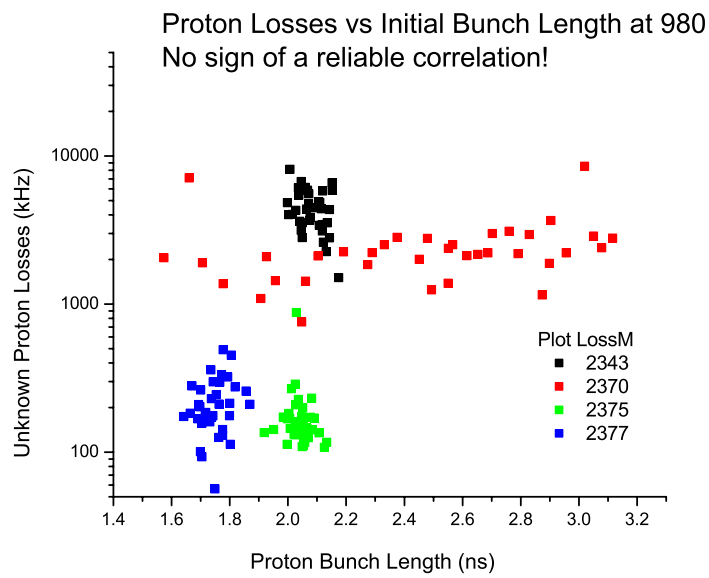


Figure 3 : Obvious lack of definite correlation between bunch length at 980 (after scraping) and the unknown loss rate

